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ABSTRACT

Recently, several systems bearing the label "instructional management systems" have been developed and reported. An analysis of such systems, however, reveals that most are limited to test-scoring and reporting functions and might best be considered instructional monitoring systems. State-of-the-art computer and educational technology is sufficiently advanced to permit development and implementation of such systems. However, true instructional management systems cannot become a reality until strategies of development and evaluation of instructional decision rules are more advanced. Prior to the development of either type of system, the specific components requiring computer support must be identified, the potential cost benefits of such support must be analyzed, and appropriate hardware/software configurations must be established. (Author/MF)

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STRATEGIES FOR DEVELOPMENT OF COMPUTER-BASED INSTRUCTIONAL MANAGEMENT SYSTEMS

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Purpose of Paper

In this paper we will: (1) analyze the common and unique components of both instructional monitoring systems and instructional management systems; (2) identify and discuss the components of both systems for which computer support may be appropriate; and (3) identify the tasks required for development of more powerful monitoring and management systems as well as harnessing the computer to specific components of these systems.

Definition of Instructional Management

The term "instructional management" although relatively new, is coming into widespread use within the educational community. There is yet, however, no clear definition of what the term means other than the implication that it has something to do with the instructional decisions made subsequent to an analysis of quantitative or qualitative pupil performance information.

What is instructional management and how does it differ, if at all, from instruction? Instruction may be defined as the process of presenting stimulus sequences (and eliciting responses) designed to bring specified learner behaviors under the control of specific stimuli. Instructional management, on the other hand, is the process of making decisions such as:

How should it be administered (for whom or what)?

When should it be given?

What, if any, contingencies are to be established?

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The who in the above question consists of either a pupil or group of pupils to whom the teacher must provide independent instruction. The what consists of the instructional alternatives available to attain a specified objective. The how relates to the type of instruction to be provided and the vehicle of instruction (e.g., teacher, aide, tutor, computer, self-instructional workbook, AV device, etc.). The when, how much, and for how long decisions are a function of a complex of variables such as the amount and type of practice needed by pupils at specific performance levels, the amount of time available for instruction in the specified curricular area, the availability of instructional support personnel, and the physical constraints of the classroom. The application of contingencies is also tied to many variables, intrinsic and extrinsic to the school.

An instructional management system should have, as its nucleus, specific empirically-verified rules for generating answers to the above questions. The output of the system should be in the form of prescriptions for specific educational actions to be taken by the teacher.

Instructional Management vs. Monitoring Systems

Several systems bearing the label "instructional management system," have recently been developed and reported. An analysis of such systems, however, reveals that most are limited only to test scoring and reporting functions. They yield an array of information for the teacher which she may use in whatever manner she sees fit. Research and development of such systems focus primarily on the identification of the most appropriate formats and types of information used by the teacher, methods of improving the hardware/software components and the operational-logistical procedures.

Such systems might best be considered instructional monitoring systems since their function is to provide a reporting capability. In contrast, an instructional management system would contain the elements necessary to complete the feedback loop and to effect change in the instruction (see Figure 1). Given the response data from the unit test, an instructional prescription would be generated indicating the use of specific materials. These instructional prescriptions would be generated from empirically developed and tested prescription rules.* The actions taken by the teacher relative to the use of the prescribed materials would be evaluated by administration of a second unit test. Performance on specific test items related to the prescribed material would then be used to assess its use by the teacher

It is clear that state-of-the-art computer and educational technology is sufficiently advanced to permit development and implementation of a wide variety of computer-based instructional monitoring systems. Before instructional management systems can become a reality, however, extensive research and development is required on the strategies for development and evaluation of instructional decision rules.

Instructional Monitoring and Management System Component Tasks

This section will analyze the components of a generalized instructional monitoring and management system (IMMS), identify the tasks to be performed, discuss and evaluate the potential contribution of computer support in the performance of those tasks.

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*Paper in AERA session C-60

Figure 1 is a flowchart which schematically represents a generalized IMMS. The entire system could operate in a manual mode but it is anticipated that certain components, namely those involving data manipulation and rule-based decision making, will benefit from computer control. The other components consist of student-teacher interactions best left under human control.

The computer-compatible tasks for monitoring instruction are: test scoring, data organization and storage, and report generation. To manage instruction, another task must be performed: the processing of performance data by means of rule-based logico-mathematical operations resulting in the generation of instructional prescriptions. The first task, test scoring, serves as the basis for the performance of all successive tasks. The resultant performance data must be organized and stored for convenient retrieval. In order to prepare notes, forms, and reports for self reference and external communication (to administrators, parents, and students), the performance data must be analyzed and further manipulated so that item, objective, and subject matter information is accessible on an individual, group, or class basis. If instructional decision rules have been established, they must also be applied to the performance data. This process will result in some type of instructional prescription.

Computers process information. They collect, store, retrieve, compute, compare, and format data, in addition to performing logical operations on them. While they do only that which can be done manually, they are able to perform these tasks more accurately, reliably, and far more quickly than do people. Once programmed, they can perform the same type of task endlessly unless instructed to do otherwise.

FLOWCHART OF INSTRUCTIONAL MONITORING & MANAGEMENT SYSTEM

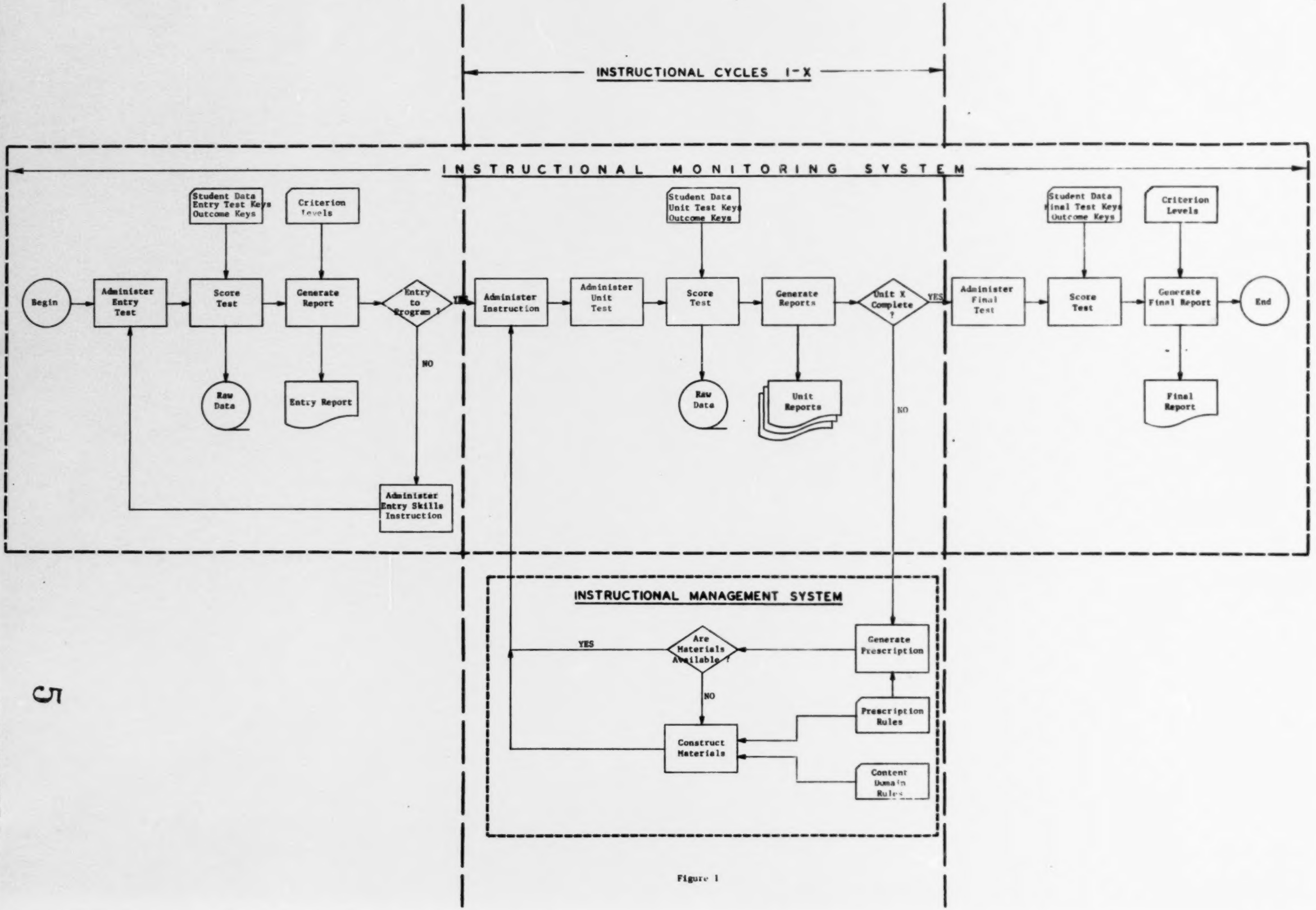

Figure 1

With this in mind, let us examine the relative benefits of the manual and computer-assisted modes of operation. Following the individual discussion of the tasks, a summary of their requirements in an automated and manual mode is presented in Table 1.

Test Scoring

Based on the present state-of-the-art, the manual mode must be used primarily with constructed responses unless there is a human interface between the tests and data input to the computer. Multiple choice tests can be scored by the computer. However, some preparatory work must be performed (i.e., inputting keys, scoring programs, etc.). This means that computer scoring will be efficient only when many tests have to be scored. It becomes particularly efficient when the same test is to be scored many times each year and in successive years.

Data Organization and Storage

Manual methods of storing and organizing information are cumbersome and may require filing stacks of paper and constantly revising record books. The computer has tremendous capabilities for storing, accessing, and updating data. To the extent that each bit of information must be randomly accessed, and accessed as a member of several sets simultaneously, so does computer assistance become more necessary and cost-effective.

Descriptive Report Generation

Computer support can save much time and effort on the part of teachers who desire and use complete records of their students' performance. There will be other teachers, however, who either do not perceive the value of

		Manual Mode	Automatic Mode
MONITORING	Test Scoring	Multiple choice tests - Devise a scoring key and/or template for hand processing of each test. Constructed response tests - Determine criteria, limits, and perhaps sample acceptable and unacceptable responses for hand processing of each test.	Develop a computer program to score multiple choice tests. Devise scoring key. Input key and response data via teletype, punched cards, CRT, or scanner-generated mag tape. Run program for output of individuals' scores and sub-scores. Constructed response tests cannot be scored unless there is human interface between tests and data input to the computer.
	Data Organization and Storage	To store all response information, tests must either be filed or a studentXitemX response matrix must be constructed. If data is to be organized by item and objective, on an individual basis or on the basis of group or class membership, a variety of charts and tables must be created.	Test items must be keyed to objectives and student ID's must be associated with groups, classes, etc. Additional statements can be added to the scoring program which will store performance data in matrices which will permit a flexible retrieval capability. In addition to pupil performance data, information pertaining to instructional alternatives and previously encountered instructional treatments must be stored.
	Descriptive Report Generation	If data has been organized on hard copy as outlined above, additional teacher reports are unnecessary. However, if notes, forms, and communiques to others are required, then they must be specially prepared by the teacher using raw data as the basis for those reports.	The program to score tests and store performance data must be expanded to include statements which will output performance data in a variety of easy-to-read formats. Each time a test is given (or on command, for that matter) single test or cumulative data can be generated automatically in forms appropriate to the needs of teachers, pupils, parents, and administrators.
MANAGEMENT	Rule-Based Processing and Generation of Prescriptions	In order to prescribe subsequent learning experiences for students or groups, teachers have to examine performance data, compare them to preestablished and empirically validated minimal performance standards, and make appropriate prescriptive decisions. Once the prescriptive decision has been made, the teacher implements the decision by taking some type of action (regrouping, changing instructional pace, assigning specific remedial treatments, or creating materials especially designed for individual students' learning deficiencies).	Additional programming will be required to enable the computer to compare pupil performance data (single test or cumlative test data) with validated instructional treatment data. A further extension of the basic monitoring program must be created which would allow decision rules to be input to the computer. These statements of logical and computational operations, in conjunction with formating statements, would process performance data in such a way as to output prescriptive suggestions. If such a program accesses a lesson generating subroutine, that section of the program can generate individually-tailored lessons automatically.

Table 1

maintaining complete records of pupil performance, or who are hostile to the idea. The installation of computer-based educational systems will require new techniques of facilitating their acceptance. It is possible that by focusing the teacher's attention on the students' post-instructional behavior (via the computer-generated reports), they might then begin making instructional decisions based on the data furnished. It is likely, however, that more systematic installation and training strategies will be needed to assure wide usage by teachers.

Computer-generated reports, with varying content and format, may also expedite communication between teachers and parents, as well as between teachers and their supervisors (e.g., individual student report to parent and class summary report to principal). While such reports may be constructed manually, the process consumes considerable time. Finally, longitudinal progress reports can be more easily assembled by a computer than by a teacher. Thus, subtle differences and trends can be identified, which might not otherwise be spotted by the teacher or administrator.

Rule-Based Processing and Prescription Generation

As the assignment of effective prescriptions becomes more systematic, it is likely that the rules for such assignment will operate on increasingly more specific information, accumulated over time and related to a number of variables. At this point, computer assistance for prescriptive rule processing will be required.

The generation of prescriptions has, as its input, performance data and decision rules. The output is a prescription - either a direct

action, a printed directive, or the latter, plus specially prepared instructional materials. If a computer is being used for monitoring and rule processing, the output function should logically follow. It is in the actual construction or compilation of individually tailored lesson material, however, that the advantages of computer over manual methods should become evident. The computer could store performance data, a record of previous instructional treatments, prescriptive decision rules, the content domain, and formating programs. It could then process all the information on an individual or group basis resulting in a set of instructional materials unique to the particular needs of each individual or group. The development of such materials in a manual mode could be difficult at best.

Classroom Organization and Curriculum Considerations

By now it should be obvious that computer support for instructional monitoring and management must be considered when the data processing tasks of the teacher become cumbersome. The unwieldiness of data processing is directly related to:

1. the number of academic subjects being managed and the number of objectives per subject
2. the number of groups and/or individuals receiving differential instruction
3. the number of instructional alternatives available for the achievement of each objective

4. the frequency of testing, number of objectives and items per test, number of students tested, and the specificity of test analysis
5. the amount of cumulative data that will be used in performance analysis
6. the complexity of decision rules for the assignment of remediation and group reconstitution
7. the frequency of group reconstitutions

There is also an increased need for computer assistance in the monitoring and management of instruction to the extent that: (1) each student selects his own goals for a variety of objectives; (2) he receives independent instruction and remediation when appropriate; (3) he interacts with a multiplicity of instructional resources at his own pace; and (4) he is tested frequently to determine the effects and adequacy of previous instruction and to insure that future learning opportunities lead to success. Some of those opportunities are especially designed to suit that student's interests and previously demonstrated abilities.

In contrast, the development of a computer-assisted instructional monitoring and management system would hardly be worth the effort for situations where

1. a teacher administers instruction to an entire class or to several permanent subgroups in order to attain a small number of major objectives

2. she has at her disposal few instructional resources (usually one book per student per subject)
3. she rarely tests pupil performance
4. she makes few (other than ranking) decisions on the basis of the test information

System Development Considerations

Computer support for Instructional Management Systems can be seen as a tripartite developmental activity including the development of: (1) a data transmission network to input pupil response data (and other relevant information) and output reports to teachers, administrators, etc. (monitoring), and instructional prescriptions (management); (2) computer programs which perform the required analytic and formating tasks in the transformation of "input" to "output;" and (3) suitable processing equipment to perform these operations.

The data transmission network may consist of optical scanners, teletypes, or other I/O equipment for inputting data with the system from a school site and for transmitting computer-generated reports via phone lines to the school site. A detailed analysis of the different hardware configurations are discussed in a related paper.*

Another major developmental requirement is that of generating the program that will execute the specific data processing tasks. The computer program is the heart of the computer-based instructional

*McManus, John F. Alternate Hardware Configurations for an Instructional Management System. Paper to be presented at 1971 AERA Convention.

monitoring and management system. To generate the necessary programs will require the strictest definition of the logical operations and analysis tasks to be performed. Creation of computer programs for an instructional management system, for example, will require explicit specification of the instructional decision rules and formating requirements to be used in the generation of prescriptions.

Resource Allocation

Computer compatibility does not necessarily imply computer desirability. In education, money (or lack thereof) is a prime consideration in the implementation of any new program or system. Thus, the implementation of a computer support system should be accomplished only after a detailed comparison has been made between the cost benefits of computer-supported and manual modes of operation. To accomplish this, questions such as the following, must be asked: Can the present staff perform the desired functions adequately? If not, could they be performed by an expanded staff? If a computer-based system is to be used, will it be possible to purchase or lease computer hardware? Is the software available, and if not, is there enough time and money to adapt available programs or to develop new ones? What are the relative cost benefits of each approach? The answers to these questions will determine the appropriateness of a computer-managed instructional system for the desired applications.

In summary, prior to the development of computer-based instructional monitoring and management systems, the specific components requiring

computer support must be identified; the potential cost benefits of such support must be analyzed, and appropriate hardware/software configurations must be established. The most critical task, however, in the development of such systems, will be the development and validation of instructional decision rules.